

FACSIMILE TRANSMISSION OVER PACKET NETWORKS WITH DELIVERY  
NOTIFICATION

**FIELD OF THE INVENTION**

The present invention relates generally to  
5 communication systems, and specifically to systems and  
methods for facsimile transmission over packet networks.

**BACKGROUND OF THE INVENTION**

Facsimile transmissions (fax) are conventionally  
carried over circuits of the public switched telephone  
10 network (PSTN), in accordance with the T.30 protocol  
standardized by the International Telecommunications  
Union (ITU-T), which is incorporated herein by reference.  
Because of the high volume and high cost of sending faxes  
over the PSTN, there is increasing demand for fax  
15 services over packet networks, including fax over  
Internet Protocol (FoIP), frame relay and Asynchronous  
Transfer Mode (ATM) networks. A number of companies now  
offer services and equipment for fax transmission over  
packet networks, for example, Telogy Networks  
20 (www.telogy.com) and Miltel Telecommunication  
(www.milcoms.com).

Fig. 1 is a message flow diagram that schematically  
illustrates the essential elements of the T.30 protocol.  
The protocol is divided into five phases:

25 A. Call establishment - The sending fax terminal  
sends a calling tone (CNG), and the receiving fax  
terminal answers with a called terminal  
identification (CED).

B. Control and capabilities exchange - In this stage,  
30 the two terminals identify their capabilities and  
negotiate the conditions (such as data rate) of the

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5,828,468, whose disclosure is incorporated herein by reference. Even with spoofing capabilities, however, real-time fax is demanding of network resources and will fail when there is a packet delay of more than a few seconds, as may easily occur in a congested IP network.

#### SUMMARY OF THE INVENTION

In preferred embodiments of the present invention, aspects of session fax operation are integrated into a real-time packet network fax system, in order to solve the problem of network delays. A gateway establishes a real-time fax connection over the packet network between a sending fax terminal and a receiving fax terminal. When a substantial packet delay occurs in the network, the gateway enters a session fax mode in order to maintain the connection. In this mode, the gateway preferably creates one or more fill pages of fax data, and transmits the pages to the sending or receiving terminal, as required. The fill pages take the place of the real page or message that is expected from the other terminal, but has not yet arrived. Preferably, the fill pages contain a suitable message, informing a user of the terminal that a network delay has occurred. Alternatively, the gateway may insert substantially any type of content in the fill pages. When the delayed page or message finally does arrive, the gateway sends it to the terminal.

The gateway keeps track of the pages and messages that it receives, and sends the appropriate end-of-procedure or confirmation message to the sending or receiving terminal only after having received all of the expected real data and messages. In this manner, the sending terminal receives confirmation of transmission

The present invention thus offers a novel solution to the inadequacy of the real-time packet fax protocol (T.38) in the face of long and unpredictable packet delays, which commonly occur in congested networks. While deviating from the T.38 standard, preferred embodiments of the present invention still maintain full compatibility with existing T.30 fax terminals. These preferred embodiments are particularly suited to fax over IP network applications, but can also be adapted for use in fax transmission over packet networks of other types, such as ATM and frame relay networks.

15 In preferred embodiments of the present invention,  
gateways with session fax capability, as described above,  
are linked to either or both of the sending terminal and  
the receiving terminal. After establishing the call, the  
gateway at the receiving side awaits pages of fax data  
20 from the sending terminal. When a page does not arrive  
in time to prevent a timeout by the receiving terminal,  
the gateway sends one or more fill pages. Once all of  
the actual fax data for the page have finally arrived,  
the gateway sends the complete page to the receiving  
25 terminal.

The gateway at the sending side gives the sending terminal a confirmation of receipt of each page, without necessarily waiting for an actual confirmation message from the receiving terminal. After the sending terminal has sent the last of the pages, the gateway awaits the last of the actual confirmation messages from the sending terminal. If the last confirmation message does not

arrive in time to prevent a timeout, the gateway preferably performs a line turnaround, as provided by the T.30 standard, instructing the sending terminal to begin receiving pages. The gateway then sends one or more fill  
5 pages to the sending terminal, until the actual confirmation (or failure indication) has returned from the receiving terminal.

There is therefore provided, in accordance with a preferred embodiment of the present invention, a method  
10 for facsimile transmission over a packet network, including:

establishing a facsimile call between first and second facsimile terminals in accordance with a facsimile protocol, using a facsimile gateway to convey  
15 communications between the terminals over the packet network;

awaiting arrival at the gateway of a signal conveyed over the packet network from the first terminal, to be transmitted from the gateway to the second terminal as  
20 provided by the protocol;

transmitting a fill page from the gateway to the second terminal if the signal does not arrive within a time limit determined in accordance with the protocol; and

25 receiving the signal at the gateway and transmitting the signal from the gateway to the second terminal after transmitting the fill page.

Preferably, the facsimile protocol includes a T.30 protocol of the International Telecommunications Union  
30 (ITU-T), and the packet network operates in accordance with an Internet Protocol (IP). Further preferably, establishing the facsimile call includes establishing a

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15           There is also provided, in accordance with a preferred embodiment of the present invention, a method for facsimile transmission over a packet network, including:

receiving a first page of facsimile data from the  
sending terminal at the gateway;

transmitting a confirmation signal from the gateway to the sending terminal after receiving the first page at the gateway, without having waited to receive a first  
30 confirmation packet over the network indicating that the first page was received at the receiving terminal;

responsive to transmitting the confirmation signal,  
receiving a second page of facsimile data from the  
sending terminal;

conveying the second page of the facsimile data over  
5 the packet network to the receiving terminal;

awaiting arrival at the gateway of the first  
confirmation packet and of a second confirmation packet  
over the network indicating that the second page was  
received at the receiving terminal; and

10 responsive to the first and second confirmation  
packets, sending a notification from the gateway to the  
sending terminal before terminating the facsimile call  
that the pages were delivered to the receiving terminal.

Preferably, establishing the facsimile call includes  
15 initiating a real-time fax over IP connection, and  
sending the notification includes completing the call in  
a session fax mode. Further preferably, establishing the  
facsimile call includes establishing the call over a  
telephone line between the sending terminal and the  
20 facsimile gateway, wherein the gateway includes a sending  
gateway, and wherein conveying the first and second pages  
of the facsimile data includes conveying the pages from  
the sending gateway over the packet network to a  
receiving gateway, which transmits the pages to the  
25 receiving terminal.

There is further provided, in accordance with a  
preferred embodiment of the present invention, apparatus  
for facsimile transmission over a packet network,  
including a computer gateway, in communication with the  
30 packet network and configured to establish a facsimile  
call between first and second facsimile terminals in  
accordance with a facsimile protocol and to convey

communications between the terminals over the packet network during the call, the gateway being adapted to await arrival of a signal conveyed over the packet network from the first terminal, which signal is to be transmitted from the gateway to the second terminal as provided by the protocol, and to transmit a fill page to the second terminal if the signal does not arrive within a time limit determined in accordance with the protocol, and upon receiving the signal, to transmit the signal to the second terminal after transmitting the fill page.

There is moreover provided, in accordance with a preferred embodiment of the present invention, apparatus for facsimile transmission over a packet network, including a computer gateway, in communication with the network and configured to establish a facsimile call with a sending terminal, the gateway being adapted to receive a first page of facsimile data from the sending terminal, to convey the first page of the facsimile data over the packet network to a receiving terminal, and to transmit a confirmation signal to the sending terminal after receiving the first page without having waited to receive a first confirmation packet over the network indicating that the first page was received at the receiving terminal, and further being adapted to receive, responsive to the confirmation signal, a second page of facsimile data from the sending terminal and to convey the second page of the facsimile data over the packet network to the receiving terminal, and still further being adapted to await arrival over the network of the first confirmation packet and of a second confirmation packet indicating that the second page was received at the receiving terminal and, responsive to the first and

5       There is furthermore provided, in accordance with a preferred embodiment of the present invention, a computer software product for facsimile transmission over a packet network, including a computer-readable medium in which program instructions are stored, which instructions, when  
0       read by a facsimile gateway computer in communication with the packet network, cause the computer to establish a facsimile call between first and second facsimile terminals in accordance with a facsimile protocol and to convey communications between the terminals over the  
5       packet network, to await arrival of a signal conveyed over the packet network from the first terminal to be transmitted from the computer to the second terminal as provided by the protocol, to transmit a fill page to the second terminal if the signal does not arrive within a  
20       time limit determined in accordance with the protocol, and upon receiving the signal, to transmit the signal to the second terminal after transmitting the fill page.

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The present invention will be more fully understood  
20 from the following detailed description of the preferred  
embodiments thereof, taken together with the drawings in  
which:













replies to the DTC by sending a DIS to gateway 24, and the gateway responds with a DCS, training and TCF signals. Upon receiving the CFR from terminal 22, gateway 24 begins to send the fill pages of step 54. The  
5 last page sent by gateway 24 will typically be the delivery notification of step 56. Alternatively, the delivery notification may take the form of a special ring invoked at terminal 22.

Fig. 5 is a flow chart that schematically  
10 illustrates a method of communication between gateway 30 and receiving terminal 32, in accordance with a preferred embodiment of the present invention. At a call establishment step 60, after receiving the request from gateway 24 to open the call, gateway 30 sends a CNG to  
15 terminal 32 and receives the terminal's CED in return. Gateway 30 then receives the DIS from terminal 32 and awaits a DCS packet from gateway 24, at a DCS reception step 62. If the DCS packet is not received in time to prevent a timeout by terminal 32, gateway 30 sends its  
20 own, default DCS to terminal 32, followed by training and TCF signals, at an interim training step 64. This step is described in detail hereinbelow with reference to Fig. 6. When the training is complete, terminal 32 sends a CFR signal to gateway 30 (not shown in the figure).

25 Once the training has been completed, gateway 30 waits for data from gateway 24, at a data reception step 70. Preferably, gateway 30 waits to receive a complete page of data before sending it on to terminal 32. If a complete page of data is not received in time to prevent  
30 a timeout by terminal 32, gateway 30 sends one or more fill pages, at a page delay step 72. As in the example of Fig. 3, these pages preferably carry a message to the

operator of terminal 32, such as "Network delay encountered - awaiting data." Alternatively, gateway 30 may begin sending data to terminal 32 after only part of a page has been received from gateway 24. In this case, if the gateway 30 is unable to send the remainder of the page in time, terminal 32 may send a RTN or RTP response to gateway 30. Gateway 30 then handles the retraining procedure appropriately while waiting to receive the remainder of the page from gateway 24.

Once gateway 30 has received a full page of data, it sends the page to terminal 32, at a data sending step 74. The page ends with a return-to-control (RTC) signal (which is a sequence of six end-of-line (EOL) characters), in accordance with the T.30 standard. At a page end step 76, gateway 30 awaits a MPS or EOP packet from gateway 24, marking the end of the page. If neither signal is received in time to prevent a timeout, gateway 30 sends a MPS to terminal 32, at a multi-page step 78. Gateway 30 may also send fill pages if necessary, while awaiting the actual MPS or EOP packet from gateway 24.

When the MPS or EOP packet does arrive from gateway 24, at a page end signal step 80, gateway 30 decides what signal to send to terminal 32. If the packet carries a MPS, gateway 30 sends the MPS to terminal 32 at an additional multi-page step 81. The gateway then waits for the next page of data at step 70. On the other hand, if the packet carries an EOP signal, gateway 30 sends the EOP to terminal 32, at an EOP step 82, after it has finished sending any fill page that has been required. When terminal 32 has received the final page and the EOP, it returns a MCF to the gateway (not shown in the figure). Gateway 30 returns the packetized MCF to gateway



